1936

The effect of the plane of nutrition of ewes upon their wool, lamb, and milk production

Maynard Goldman Snell

JANUARY, 1936 LOUISIANA BULLETIN NO. 269

The Effect of the Plane of Nutrition of Ewes upon Their Wool, Lamb, and Milk Production

By
M. G. SNELL

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATIONS
C. T. DOWELL, *Director*

The Effect of the Plane of Nutrition of Ewes upon Their Wool, Lamb, and Milk Production

By M. G. SNELL
Louisiana Agricultural Experiment Station

SUMMARY

One of the problems of the wool grower on the cutover areas of Louisiana is the loss of wool during the winter. Examination of large numbers of sheep in the eastern area by a representative of the Bureau of Animal Industry showed this condition not to be due to scab.

The Louisiana Agricultural Experiment Station, in an attempt to solve this problem, conducted a three-year experiment consisting of four lots of 10 ewes each fed in dry lot. Lot I was full fed, lot II full fed eight months, and one-third full fed for four months, lot III two-thirds full fed, and lot IV one-third full fed. Data on live weight, wool production, lambing, and milk production were secured on the ewes; birth and 120-day weights and measurements were secured on the lambs. The conclusions drawn from these data are summarized as follows:

Ewes on a high plane of nutrition produce more lambs, are better mothers, and are better producers of wool than ewes on a low plane of nutrition.

Ewes full fed eight months and then fed on a very low plane of nutrition for about four months produce fewer lambs, less milk, lambs weighing less at the end of 120 days, and less wool than do ewes fed a good ration the year round.

Ewes fed an extremely poor ration are poor mothers, poor milkers, poor breeders, have light lambs at weaning time, and shear light fleeces.

A low plane of nutrition may result in the shedding of wool.

A low plane of nutrition fed to the mother reduces the weight of the lamb at 120 days, but does not have any consistent effect upon the lamb's wool up to 120 days.

A low plane of nutrition, such as was fed in this experiment, does not increase the ability of the ewe to digest feed.

The practical lesson to be drawn from these data is that year-round care and attention will result in (1) thriftier ewes that are heavier milkers and better mothers; (2) an increased number of lambs being born; (3) a larger percentage of lambs being raised; (4) larger lambs at weaning time; and (5) heavier fleeces.

INTRODUCTION

The shedding of wool by sheep is one of the problems of the wool growers of the cutover lands throughout their lifetime. They have no shelter other than that afforded by nature, are not fed during the winter, and receive little attention other than branding, marking, and shearing.

Sheep handled under these conditions may come through the winter in good condition, raise a good crop of lambs, and shear heavy fleeces of wool, but frequently large numbers of grown sheep are lost, the wool clip is light, and few

lambs are raised. In addition, many of the sheep may shed their fleeces either partially or entirely.

Wool sheeding seems most widespread after wet winter and spring months. Sheep will start losing wool in small patches and may continue to lose it until most or all of the fleece has been shed.

REVIEW OF LITERATURE

As early as 1848, Youatt (1848) states that both climate and feed affect diameter, length, and amount of wool produced by sheep. Recent writers have expressed these same views.

Masterdon (1926), in an article on wool growing in New Zealand, states that the appearance of the wool can be altered in a very short time by the different types of soils. According to him, both the crimp and yolk will be altered; light soils produce finer and lighter fleeces; strong, heavy clay soils will produce wool with little crimp and a lack of character; limestone soils will grow strong wool with a hard feel.

Roux (1926), of South Africa, while studying at one of the larger universities of the United States, wrote that climate and soil conditions are the most important factors controlling the production of good quality wool, the best quality wool being grown in a country suitable for short, sweet grass. Colder countries tend to produce dense, finer fleeces with more yolk; arid conditions, longer wool with less density, coarser, and with a tendency toward harshness.

Another idea (Anonymous, 1922) concerning the effect of feed on wool production is contained in a popular article in a London, England, livestock journal. According to this writer, the growth of wool will not be affected so long as the liveweight of the animal is maintained. Liberal feeding may give a heavier fleece, but the difference was thought to be due to an increased deposition of wool fat rather than to an increase in wool fiber.

Experimental evidence tends to sustain these popular views.

Cook and Jones (1891) noted that the diameter of wool fiber produced by a ewe during sickness was smaller than that produced during normal health. Wilson (1934, 1935) found that a purebred Lincoln ewe produced wool during a four months' sick spell at a reduction of 42 per cent in the rate of growth, in length, and in diameter, showing that sickness reduces both the length and diameter of the wool fiber grown, as well as the total amount of wool grown.

Craig (1896) reported the effect upon their wool production of three methods of feeding lambs to approximately 10 months of age. The lot I lambs were grain fed from birth to market age, lot II from weaning to market age, and lot III for a two months' fattening period. The grease weights of wool were 8.7 pounds, 7.5 pounds, and 7.5 pounds, respectively. The shrinkage percentages were 43.0 per cent, 37.1 per cent, and 38.0, respectively. The yields of clean wool were 4.9 pounds, 4.7 pounds, and 4.5 pounds. The lambs getting grain for the longest period of time produced the heaviest fleeces with the greatest shrinkage, but with the greatest amount of wool fiber. These figures indicate that feed affects both the growth of wool fiber and the percentage yield or shrinkage.

Russel (1913) reports three years of work at the Wisconsin station in which rations high and low in sulphur were fed to sheep. No effect was noted upon the gross weight, the shrinkage, or the clean wool content of the fleeces.

Hammond (1916) found that April-shorn sheep produce more clean wool but less grease wool than sheep shorn in June.

Zuntz (1920) kept sheep at a constant weight on a ration of straw and beets. One group of two animals received daily from 8 to 10 grams of digestible horn in addition. After four months, the fleeces of the group receiving horn showed more strength (development) than that of the other group. Microscopic examination showed the wool fibers to have increased about one-third in diameter and each single fiber had strengthened itself.

Hill (1921) found that a group of 60 wethers sheared 4.09±.07 pounds each of clean wool when taken off a Wyoming range. For the following three years when fed under dry lot conditions they averaged 5.19±.08 each. He concludes from these data that range sheep do not ordinarily get enough feed to bring out fully inherent capacity for the production of wool.

Henry and Morrison (1922) state that Wilson and Kuhlman at the South Dakota station increased the wool yield of lambs 9 per cent by adding linseed meal to a ration of corn, oats, and prairie hay.

Hammond (1922) found that ewes wintered on a daily ration containing 0.63 pound of corn and 0.12 pound of linseed meal plus hay and silage average 7.87 pounds of wool. A similar group of ewes wintered on a similar ration, except that they received 0.4 pound of corn and 0.35 pound of linseed meal daily, sheared 8.23 pounds of wool. Here the replacement of 0.23 pound corn with a similar amount of linseed meal increased the average yield of wool by 0.96 pound.

Lush and Jones (1923) found that the individuality, age, and sex affected the fleece weights of fine wool sheep run under range conditions.

Evvard and Culbertson (1924) fed ewes on rations containing the following amounts of salt daily: none, one-fourth ounce, one-half ounce, and one ounce. The average fleece weights per ewe were 7.03 pounds, 8.04 pounds, 8.52 pounds, and 7.65 pounds, respectively.

Joseph (1927), from wool studies with fine wool sheep under varying conditions, concludes (a) that the wool fiber is not easily affected by a change in the level of feeding for a period of five or six months; (b) that quality of the wool fiber is not affected at all; (c) that the quantity of wool fiber may be modified only slightly as long as the sheep remain in normal health; and (d) that the age of the wethers affects the diameter of the wool fiber only slightly, but after from three to four years causes a decrease in length of wool fiber.

Spencer, Hardy, and Brandon (1928) state (1) that age affected the length of wool fiber in that as the age of the ewe increased the length of wool fiber decreased, and (2) that fleeces from ewes three years of age averaged heaviest and those over five years of age lightest. Heavy shrinkage was associated with the shorter fleeces. The longer fleeces were heavier, had less grease and dirt (shrinkage), but were a little less dense.

Hardy and Tennyson (1930) found that the rate of growth of wool and the fineness of fibers produced varied throughout the year, both the rate of growth and the diameter of fiber being greatest in fall and least in midwinter. The period of most rapid growth was associated with the largest diameter of wool fiber, while the period of greatest wool growth was associated with the period of general thrifty condition, as indicated by its weight. The period of least wool growth was associated with lambing time and the 45 days preceding. This experiment shows a rather close association between the thriftiness of the sheep and the quantity and quality of wool produced.

Wilson (1931) fed three Romney wethers on a fattening ration for six months. This was followed by a maintenance period of six months and then by a six

months' feeding period in which the wethers were on a submaintenance ration. The wools grown during the first and third periods were compared. The first six months' period produced about three times as much grease and clean wools as the third period. Furthermore, the wool was larger in diameter, about twice as strong, almost twice as long, was loftier, and had a superior crimp to that produced during the third or submaintenance period.

Weber (1931) fed sheep on a low plane of nutrition followed by full feed. When on full feed the sheep produced 100 per cent more scoured wool than when on a low plane of nutrition, and the fibers were 15 per cent larger in diameter and 14 per cent longer.

Marston (1932) found the feeding of 100 lambs with blood meal containing 2.7 per cent cystine increased the wool yield over 35 per cent. About 40 per cent of the ingested cystine was recovered in the fleece.

Hill (1912) reported on the use of the fiber-testing machine for measuring the strength and elasticity of wool. Hardy (1918, 1920) found both temperature and humidity affected the elasticity and strength of wool fibers.

Burns and Koehler (1925) and Burns (1935) found the micrometer caliper satisfactory for the measurement of diameter of wool fibers.

SHEDDING IN LOUISIANA

In the spring of 1930, groups of sheep were counted at numerous places on the range and the number of shedding sheep noted. On the average, 6 out of every 25 grown sheep had shed their fleeces either partially or completely. In some cases, only a small patch of wool would be missing; in others, the sheep had shed practically its entire fleece.

SHEDDING NOT DUE TO SCAB

In some cases the sheep would seem irritable, rub or gnaw itself, and show other symptoms of scab infection. A representative of the Bureau of Animal In-

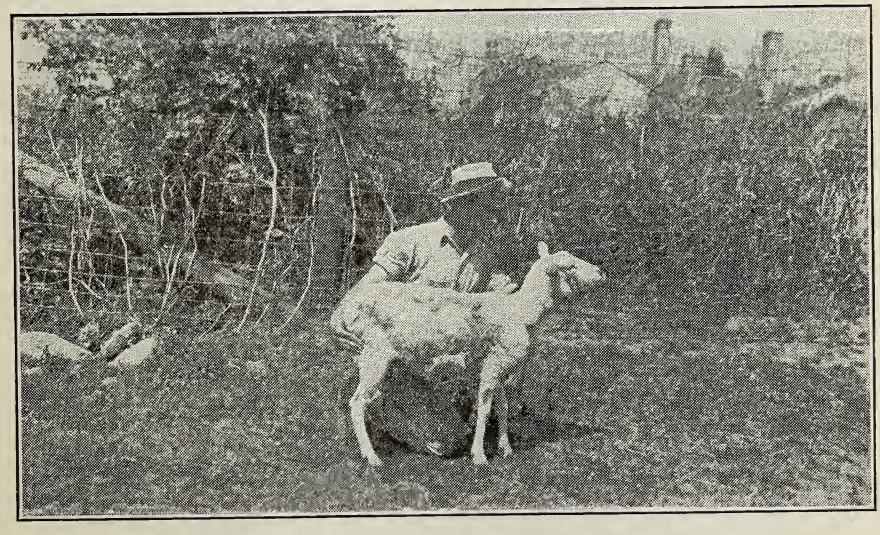

FIGURE 1.—Poor feeding produces shedding. This ewe shed practically her entire fleece.

dustry was called in and approximately 20,000 sheep were examined. Scab was not found; hence, feed and range conditions seemed to offer the most likely solution to the problem.

EXPERIMENTAL PROCEDURE

The life of a ewe on the cutover range falls into about three definite periods. Beginning in June the ewe is shorn. From then to October, the chances are that she has good grazing, suckles her lamb, and has a fairly easy time. From October to February or March the grass is dried up and grazing is short. The ewes get thin and the mortality rate may be high. In February the grass starts coming out and with the spring months there comes a new crop of lambs. Hence, the year may be divided into (1) February to June, lambing and lamb nursing months, (2) June to October, largely months of good grazing, and (3) October to February, the winter period.

In an attempt to duplicate these range conditions and at the same time to get information on the effect of feed upon wool, milk, and lamb production, the Louisiana Agricultural Experiment Station started an experiment as follows: In June, 1931, 40 head of grade Cheviot ewes were divided into four lots of 10 head each. The lot I ewes were given all the feed they would consume; the lot II ewes were fed the same as the lot I ewes for eight months, but for four months, representing the winter feeding period, they received only one-third as much as the lot I ewes. The lot III ewes were fed two-thirds as much as the lot I ewes, while the lot IV ewes were fed only one-third as much as those in lot I. This feeding plan was followed for three years, with one exception. During the winter months (October 1 to February 1) of 1932, the lot II ewes were fed the same as the lot I ewes, but received only one-third of a full feed during the suckling period, February 1 to June 1.

The ration fed consisted of 60 parts hay and 40 parts grain. Accurate records on feed consumption were kept throughout the three years. The ewes were weighed regularly every 28 days. Birth and 120-day weights and measurements were obtained on the lambs. Individual wool samples were taken from each ewe at the end of each

TABLE I. AVERAGE DAILY FEED CONSUMPTION BY PERIODS

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	2.583	2.583	1.722	0.861
2	3.719	1.240	2.480	1.240
3	3.750	3.750	2.500	1.250
	1932-1933			
1	3.326	3.305	2.283	1.143
2	3.000	3.000	2.000	1.000
3	3.000	1.000	2.000	1.000
	1933-1934			
1	3.183	3.183	2.122	1.061
2	2.592	0.862	1.725	0.862
3	2.454	2.448	1.636	0.818

The average weights by lots, periods, and years are shown in table II.

period, namely, June 1, October 1, and February 1. Wool lengths, diameter, and crimp of fiber were determined from these individual small samples, micrometer calipers being used to determine the diameter of wool fibers. Wool weights were secured at shearing time. Shrinkages and scoured fleece weights were determined from samples secured at this time.

The average daily ration fed each ewe in each lot for each period is shown in table I.

TABLE II. AVERAGE WEIGHTS OF EWES BY LOTS, PERIODS, AND YEARS

Period	Lot I	Lot II	Lot III	Lot IV
Initial weight	68.4	70.0	68.4	70.4
	1931-1932			
1	83.6	83.2	73.2	53.8
2	106.8	70.0	80.1	61.3
3	112.0	92.6	81.1	51.8
Average	100.8	81.9	78.1	55.6
	1932-1933			
1	120.6	104.8	77.0	56.9
2	134.4	119.9	85.0	56.6
3	113.3	82.4	71.2	67.5
Average	122.8	102.4	77.7	60.3
	1933-1934			
1	115.4	106.2	83.6	68.7
2	123.1	77.3	72.0	54.4
3	96.5	94.0	65.5	60.5
Average	111.7	92.5	73.7	61.2
	AVERAGES			
1	107.3	98.1	77.9	59.8
2	121.4	89.1	79.0	57.4
3	107.3	89.7	72.6	59.9
Average	112.0	92.3	76.5	59.0

ANALYSIS OF VARIANCE

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value— Obtained	Significant Value
Total	359	2,793.4	----------	-------	-----
Within	324	1,008.9	3.114	-------	-----
Between years	2	83.79	41.895	13.43	3.03
Between lots within years	9	1,416.51	157.390	50.54	1.97
Between periods within year and lot	29	284.22	11.842	3.80	1.55

This table shows the ewes in all lots at the beginning of the experiment to weigh approximately 70 pounds, but at the end of the first year, the lot I ewes had

gained approximately 30 pounds, while the lot IV ewes had lost about 14 pounds. The average weight for the three years shows the lot I ewes to weigh almost double the lot IV ewes.

The average weights by periods show the lot I ewes to be heaviest during the winter months when pregnant. The lot II ewes varied in weight according to the amount of feed fed, while the lot III and lot IV animals tended to maintain a more or less uniform weight.

The lot I ewes were able to increase their weight in order to take care of the growing foetus. Lots III and IV remained more or less constant in weight throughout the year, which indicated that possibly these ewes were growing their foetuses in part, at least, at the expense of their own body tissues.

The average fleece weight, yield percentages, average scoured weights, and average length of the fleeces are shown in table III.

TABLE III. GREASE WEIGHTS, YIELD PERCENTAGES, AND SCOURED WEIGHT OF THE FLEECES

Lot	Year	Grease Wgt. lbs.	Yield %	Scoured Wgt. lbs.	Staple Length cm.
I	1	5.26	61.21	3.20	10.92
	2	6.05	68.22	4.18	12.70
	3	3.90	71.19	2.76	9.49
	Average	5.07—	67.07	3.38	11.04
II	1	3.63	62.65	2.34	9.88
	2	3.68	63.45	2.30	10.05
	3	2.10	67.42	1.35	8.43
	Average	3.14	64.54	2.00	9.45
III	1	2.64	61.98	1.63	9.18
	2	2.95	67.37	1.93	9.15
	3	0.99	60.10	0.67	9.22
	Average	2.19	63.15	1.41	9.18
IV	1	0.90	63.17	0.58	7.14
	2	1.47	63.19	1.68	8.83
	3	1.30	65.17	0.85	5.75
	Average	1.22	63.84	1.04	7.24
Significant differences between periods		0.46	0.95	0.094	0.485

This table shows the amount of feed fed to have a marked effect upon the grease weight, scoured weight, and staple length of wool produced by the ewes. Contrary to the opinion sometimes expressed, an increase in feed did not cause an increase in the shrinkage of the wool, owing to an increased grease content of the fleece. Rather, the lot I ewes had less grease and dirt and more actual wool in their fleeces than did the ewes in the other lots. The length figures indicate that the lot I ewes grew more wool than did the ewes in the other lots, and that the lot IV ewes produced the least. This table shows clearly that well-fed ewes pro-

duce heavier fleeces, with less shrinkage but more length, than do ewes that are on poor rations.

One further comment should be made concerning this table. Lots II, III, and IV showed a tendency to shed. The low feeding period to which the lot II ewes

FIGURE 2.—A lot I ewe. Good feeding produces health, vigorous mothers, heavy fleeces, and strong lambs. These ewes averaged 112 pounds.

FIGURE 3.—A lot II ewe. Poor winter feed reduces the average yearly weight, the wool crop, the milk supply, and the number of lambs produced. These ewes averaged 92 pounds.

were subjected apparently weakened the fiber and caused some of the ewes to lose wool. In order to minimize this loss, the ewes in these three lots were kept in canvas covers. However, in spite of these precautions, two ewes in lot IV shed almost their entire fleeces. This tendency to shed reduces the value of the average fleece weight figures, but does seem to answer one object of this experiment, namely, that lack of feed may result in wool shedding.

From the small samples of wool secured at the end of each four-month period, data on length, diameter of fiber, and crimp per inch were secured. The average length of wool grown by the ewes in each lot is shown by periods in table IV.

TABLE IV. EFFECT OF AMOUNT OF FEED FED EWES UPON THEIR GROWTH OF WOOL IN LENGTH

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	4.05	4.27	3.46	2.97
2	4.24	3.30	3.66	2.78
3	4.12	3.45	3.57	2.78
Average	4.14	3.67	3.56	2.84
	1932-1933			
1	4.22	3.86	3.61	3.12
2	4.66	4.14	3.59	3.00
3	4.34	3.95	3.33	2.75
Average	4.41	3.98	3.51	2.96
	1933-1934			
1	4.37	4.18	4.08	3.51
2	4.60	3.54	3.63	3.11
3	3.98	3.24	2.90	3.11
Average	4.32	3.65	3.53	3.22
	AVERAGE			
1	4.21	4.10	3.72	3.20
2	4.50	3.66	3.63	2.96
3	4.15	3.55	3.27	2.88
Average	4.28	3.77	3.54	3.01

ANALYSIS OF VARIANCE*

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value Obtained	Significant Value
Total	359	.017945			
Within	324	.010625	.003279		
Between years	2	.00020	.000100	32.79	19.50
Between lots within years	9	.00599	.000665	4.93	2.71
Between periods within year and lot	24	.00163	.000679	4.83	1.73

*Coded figures; original numbers divided by 120.

The rate of growth of wool fiber was greatest with lot I ewes and least with the lot IV ewes. In the lot I ewes, the months of greatest wool growth were October, November, December, and January. In all other lots the period of greatest wool growth was from June to October. This indicates so far as the well-fed lot I ewes were concerned that late fall and winter were more ideal for wool growth than either spring or summer. The chances are that these ewes received enough feed to make their maximum growth during the fall and winter and were not annoyed as much by the heat, flies, insects, etc., as in the other two periods. Nor was pregnancy as much of a strain as was the giving birth to and nursing of lambs during the following period.

The ewes of lots II, III, and IV produced wool at their maximum rate during the summer months following shearing, indicating that pregnancy and lactation from October 1 to June 1 probably affected wool growth more than the heat and annoying insects of the summer months. In all cases, the periods of least wool growth were from February 1 to June 1, showing that lactation is a more severe drain upon a ewe, as indicated by wool growth, than is pregnancy.

Summarized, table IV indicates that (1) the period most favorable for wool growth is from October 1 to February 1, provided the ewe has all the feed she cares to eat; (2) when an adequate amount of feed is not available, the summer months are most favorable for wool production; (3) the spring months corresponding with the lactation period are the months of least wool growth; i.e., lactation is a greater drain upon the body of the ewe than is pregnancy, in so far as is indicated by wool growth.

The average diameter of wool fibers is shown in table V.

FIGURE 4.—A lot III ewe. Two-thirds of a feed is not enough to insure regular breeding, heavy fleeces, and good milk flow. This ewe lost most of her fleece. These ewes averaged 77 pounds in weight.

TABLE V. EFFECT OF AMOUNT OF FEED CONSUMED ON DIAMETER OF WOOL FIBER

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	10.358	10.27	9.52	9.50
2	9.92	8.50	9.41	7.58
3	9.35	8.72	8.39	6.61
Average	9.874	9.16	9.11	7.89
	1932-1933			
1	10.37	10.44	10.06	8.28
2	10.64	11.36	10.14	7.84
3	10.98	9.58	9.17	7.71
Average	10.66	10.46	9.79	7.94
	1933-1934			
1	11.27	10.47	9.97	8.65
2	11.03	10.29	9.54	7.36
3	10.22	9.29	8.01	7.73
Average	10.84	10.01	9.17	7.91
	Averages for Three Years			
1	11.33	10.39	9.85	8.81
2	10.53	10.05	9.69	7.59
3	10.18	9.19	8.52	7.35
Average	10.68	9.88	9.35	7.92

Analysis of Variance

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value— Obtained	Significant Value
Total	359	731.19			
Within	324	121.881	0.3762		
Between years	2	38.995	19.4975	51.82	3.03
Between lots within years	9	413.870	45.9855	122.24	1.97
Between periods within year and lot	24	156.444	6.5185	17.32	1.55

The table shows that ewes receiving a full feed produce wool with larger diameter of wool fiber than ewes receiving a smaller amount of feed. The diameter of wool fiber parallels rather closely the amount of feed fed. Likewise, the wool produced from June 1 to October 1, after the lambs are weaned, with two exceptions, averages larger than the two periods following. These two exceptions are in lots I and II for the year 1932-1933. These lots were on full feed during both periods 1 and 2. Hence, it would seem that these ewes had less demand upon their bodies during the summer and early fall months than at any other period of the year. This lessened demand upon the body is reflected in increased weights, increased length of wool, and larger diameter of wool fibers.

FIGURE 5.—A lot IV ewe and her lamb. One-third of a feed was not enough to maintain life over a three-year period. All the original ewes in this lot died. They were poor mothers, irregular breeders, and sheared light fleeces. These ewes averaged 59 pounds.

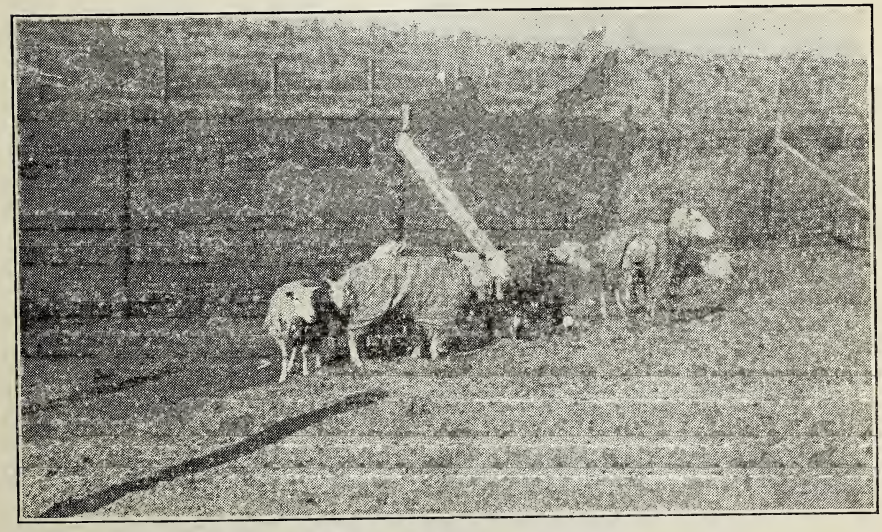

FIGURE 6.—The ewes in lots II, III, and IV were covered practically throughout the experiment in order to prevent the ewes pulling each other's wool.

The effect of the amount of feed fed upon the crimp of wool fibers is shown in table VI.

TABLE VI. EFFECT OF AMOUNT OF FEED FED UPON THE CRIMPS PER INCH OF WOOL FIBER

Period	Lot I	Lot II	Lot III	Lot IV
	1931-1932			
1	6.79	6.80	7.43	7.93
2	5.98	5.70	6.43	7.39
3	5.70	6.51	7.03	8.43
Average	6.16	6.34	6.96	7.92
	1932-1933			
1	5.74	6.04	7.38	9.00
2	4.95	5.97	7.16	8.92
3	5.53	5.24	8.41	9.80
Average	5.41	5.75	7.65	9.24
	1933-1934			
1	5.05	6.03	7.06	8.58
2	6.12	6.95	8.55	10.02
3	6.01	7.07	7.99	9.95
Average	5.73	6.68	7.83	9.52
	Averages for Three Years			
1	5.86	6.29	7.29	8.50
2	5.68	6.21	7.05	8.78
3	5.74	6.27	7.81	9.39
Average	5.76	6.26	7.38	8.89

Analysis of Variance

Source of Variation—	Degrees of Freedom	Sum of Squares	Mean Square	—Snedecor's F Value— Obtained	Significant Value
Total	359	1168.30	----------	-------	------
Within	324	481.22	1.485	-------	------
Between years	2	23.96	11.98	8.07	3.03
Between lots within year	9	580.40	64.49	43.43	1.97
Between periods within year and lot	24	82.72	3.45	2.32	1.55

Table VI, when examined with tables IV and V, shows that as the rate of growth increases, the number of crimps per inch decreases. The ewes on full feed produced longer and larger wool fibers, but with fewer crimps per inch. The ewes on a poor ration produced lighter, shorter, finer, and crimpier wool than their mates, which were receiving more feed.

The lambing data are shown in table VII.

TABLE VII. EFFECT OF FEED UPON THE PERCENTAGE OF EWES LAMBING AND OTHER LAMBING DATA

	Ewes			Lambs					
	In Lot	Lambing	Percentage Lambing	No. Born	Pct. Born Per Ewe	No. Raised	Percentage Raised	Sets of Twins	Lambs Born Dead
				Lot I					
Year 1	10	9	90.0	10	100.0	9	90.0	1	--
2	10	9	90.0	11	110.0	10	91.0	1	--
3	10	10	100.0	14	140.0	9	64.0	4	1
Total or Avg.	30	28	93.3	35	116.7	28	80.0	6	1
				Lot II					
Year 1	10	10	100.0	11	110.0	8	73.0	1	1
2	8	7	87.5	8	100.0	6	75.0	1	2
3	9	6	66.7	6	66.7	4	67.0	0	2
Total or Avg.	27	23	85.19	25	92.59	18	72.0	2	5
				Lot III					
Year 1	10	9	90.0	10	100.0	9	90.0	1	1
2	9	7	77.8	7	77.8	7	100.0	0	--
3	10	7	70.0	7	70.0	4	57.0	0	1
Total or Avg.	29	23	79.31	24	82.76	20	83.3	1	2
				Lot IV					
Year 1	10	9	90.0	9	90.0	5	56.0	0	1
2	7	4	57.1	4	57.1	3	75.0	0	1
3	7	5	71.4	5	71.43	0	0.0	0	2
Total or Avg.	24	18	75.0	18	75.0	8	44.44	0	4

Table VII shows that 93.3 per cent of the lot I ewes produced lambs, while only 75 per cent of the ewes in lot IV produced lambs. The amount of feed consumed during the year seems to have affected the lamb crop. The better the condition of the ewes, the greater the percentage to lamb. Likewise, the better the condition of the ewes, the greater the number of lambs born. Lot I had 116.7 per cent of lambs born, while lot IV had only 75 per cent. The lot I ewes had six sets of twins; lot II, two; lot III, one, and lot IV, none.

Severe underfeeding just before or during lambing as was practiced in lot II resulted in 5 out of 25, or 20 per cent, of the lambs being born dead. Such a low plane of feeding throughout the year produced 4 dead lambs out of 18, or 22.2 per cent. Hence, it seems that severe underfeeding just before lambing has almost as much detrimental effect upon the production of stillborn lambs as does severe underfeeding throughout the year.

The effect of feed upon the ability of a ewe to raise a lamb is reflected to some extent in table VII. In lot I, a total of 30 ewes (10 ewes during three years) raised 28 lambs, or 93.3 per cent. In lot IV, 24 ewes raised 8 lambs, or an average

of 33.3 per cent. The lot I ewes did not raise as large a percentage of lambs as did lot III. This is due no doubt to the larger number of twin lambs born in lot III.

Table VIII shows the effect upon the birth weights and measurements and 120-day weights and measurements of the amount of feed fed to the ewes and the gains in these weights and measurements.

TABLE VIII. EFFECT OF FEED FED EWES UPON THE BIRTH AND 120-DAY WEIGHTS AND MEASUREMENTS OF THEIR LAMBS*

	Birth Weight, Average			120-Day Weight, Avg.				Gain, Average		
Year—	No. Born	Wt., Lbs.	Heart Girth, Ins.	Length Inches	Number	Wt., Lbs.	Heart Girth, Ins.	Length, Inches	Wt., Lbs.	Heart Girth, Ins.	Length, Inches
					Lot I						
1	8	7.0	13.6	20.4	7	42.5	28.7	37.4	36.6	16.9	17.3
2	8	7.65	13.9	20.8	8	51.0	30.5	40.5	43.4	16.5	19.8
3	9	7.1	14.1	20.5	9	33.8	26.0	35.7	26.8	12.0	14.6
Total	25				24						
Average		7.21	13.88	20.54		42.06	28.29	37.81	34.9	14.92	17.14
					Lot II						
1	6	7.1	13.9	20.0	6	45.0	29.5	37.0	37.9	15.6	17.0
2	6	6.8	13.8	20.2	6	39.3	27.2	36.5	32.6	13.4	16.3
3	6	6.2	12.8	20.4	4	37.1	27.7	38.5	30.6	14.5	15.9
Total	18				16						
Average		6.66	13.48	20.18		40.91	28.19	36.56	34.11	14.52	16.49
					Lot III						
1	9	6.9	13.8	20.2	9	44.8	26.6	36.9	37.9	12.8	16.7
2	7	7.5	14.2	20.7	7	36.9	26.2	35.9	29.4	12.0	15.2
3	8	7.1	13.6	21.1	4	36.1	27.5	35.6	28.3	13.6	14.2
Total	24				20						
Average		7.14	13.88	20.67		40.27	26.65	36.31	33.00	12.67	15.69
					Lot IV						
1	8	5.7	12.7	19.3	5	34.4	25.3	34.0	28.0	12.3	14.9
2	4	4.1	9.8	14.6	3	28.2	24.0	33.2	22.8	11.3	14.4
3	4	4.2	12.6	19.6	0						
Total	16				8						
Average		5.19	11.67	19.10		32.06	24.81	33.69	26.09	11.94	14.71
					Average						
1	31	6.63	13.49	19.96	27	42.30	27.55	36.53	35.47	14.34	16.59
2	25	6.96	13.70	20.23	24	41.10	27.60	37.27	34.06	13.79	16.91
3	28	6.25	12.99	19.76	17	35.12	26.76	35.73	28.06	13.00	14.86

*Only singly born lambs used in this table. All twins excluded.

This table shows considerable variation in weights and measurements of lambs. Because of these variations, the only figures that differ significantly are 120-day weight figures, and the figures on gain in weight. The amount of feed fed the mothers

caused no significant difference in the birth weights of the lambs. At 120 days of age, the weights of the lambs did differ significantly. The lambs in lot IV were significantly lighter than lambs in the other three lots both at birth and at 120 days, in spite of the fact that the lambs in all lots were creep fed grain. The amount of milk given by the ewe might be responsible for this difference.

The average daily milk production of the ewes and the average gains of the lambs for the year 1933 are shown in table IX.

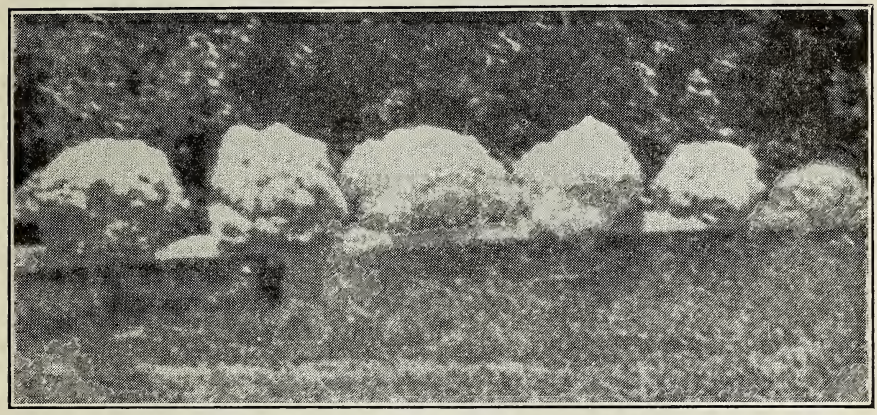

FIGURE 7.—Feed affects wool production. The lot I ewes produced 5.07 pounds of wool; lot II, 3.14 pounds; lot III, 2.19 pounds, and lot IV, 1.22 pounds.

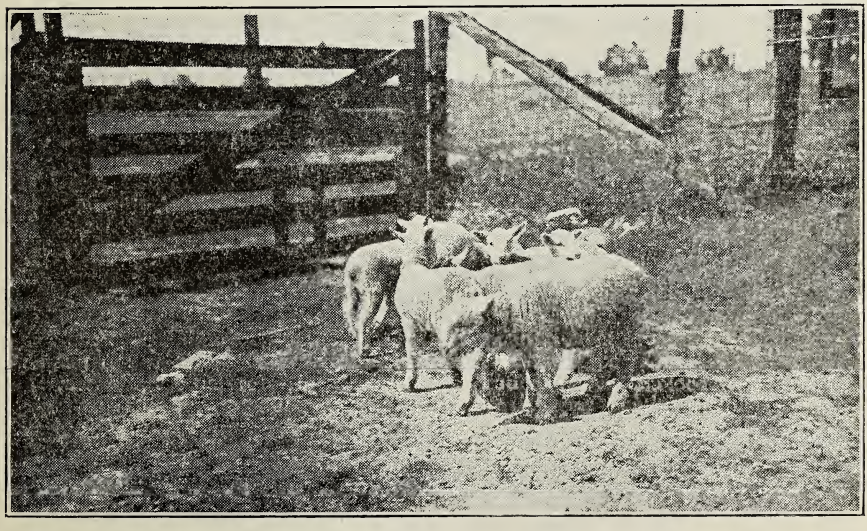

FIGURE 8.—Well fed ewes produce strong, vigorous lambs. Twenty-four lot I lambs averaged 42 pounds at 120 days of age.

TABLE IX. AVERAGE DAILY MILK PRODUCTION* TOGETHER WITH THE AVERAGE GAINS IN WEIGHT OF THEIR LAMBS. 1933

Lot	Daily Milk Production, Grams	Gain, 120-Day Wt. of Lambs, Lbs.	Remarks
I	257	45.3	Full fed
II	170	31.4	1/3 full fed
III	160	31.7	2/3 full fed
IV	76	23.0	1/3 full fed

*Average daily milk production obtained for 7-day period beginning on the 28th day after the lamb was dropped.

This table shows a rather close association between the amount of feed fed in each lot, the average daily milk production of the ewes in those lots, and average gains of the lambs from birth to 120 days.

The data secured on the 120-day wool samples of the lambs are shown in table X.

TABLE X. LENGTHS, DIAMETERS, AND CRIMPS OF LAMBS' WOOL, 120-DAY SAMPLES

Year—	Lengths, Cm.	Diameters, .0001 In.	Crimps per In.
	Lot I		
1	3.43	7.03	9.64
2	3.19	7.15	10.97
3	3.70	7.00	9.10
Average	3.42	7.06	9.96
	Lot II		
1	3.64	7.15	8.7
2	2.96	6.66	10.5
3	4.32	7.56	9.5
Average	3.60	7.10	9.42
	Lot III		
1	3.44	6.26	9.67
2	3.33	6.50	10.57
3	3.27	6.85	10.35
Average	3.38	6.43	10.00
	Lot IV		
1	3.35	5.97	10.27
2	3.70	7.81	9.1
3	-----	-----	-----
Average	3.50	6.76	9.77

The lambs showed quite wide variations in the length, crimp, and diameter of their wool fibers at 120 days. The ration fed their mothers had no consistent effect on the wool growth of the lambs up to 120 days, yet there were distinct and highly

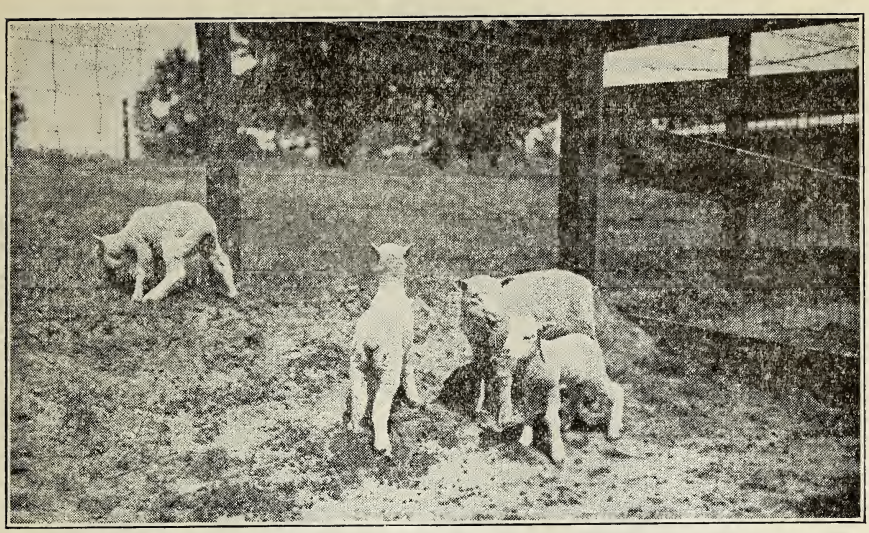

FIGURE 9.—Poor feed means few lambs and light weights. Eight lot IV lambs averaged 32 pounds at 120 days.

significant differences in their weights at 120 days. Inasmuch as a difference in the plane of nutrition of ewes caused significant differences in weight, length, diameter, and crimp of the fleeces of the ewes, it would seem logical to expect a similar difference in the fleeces of the lambs.

METABOLISM TRIALS

Three ewes from each lot were put in metabolism cages, and metabolism trials of 10 days' duration each were run.

The digestion figures obtained from these trials are shown in table XI.

TABLE XI. AVERAGE DIGESTIBILITIES OF FEED NUTRIENTS BY EWES RECEIVING DIFFERENT AMOUNTS OF FEED

LOT	RATION	PROTEIN	ETHER EXTRACT	NITROGEN-FREE EXTRACT	CRUDE FIBER
I	Full fed	62.295	77.894	78.838	58.646
II	Full fed 8 mo.				
	1/3 full fed 4 mo.	57.695	78.330	73.980	41.375
III	2/3 full fed	51.872	75.621	73.010	36.411
IV	1/3 full fed	52.144	78.598	71.652	32.399

The lot I ewes showed a higher ability to digest protein, nitrogen-free extract, and crude fiber, on the average, than did the ewes in the other lots. The lot IV ewes showed the lowest average ability of the ewes in any of the lots to digest nitrogen-free extract and crude fiber. Feeding ewes on a low plane of nutrition over

a long period of time did not increase their ability to digest feed; on the contrary, they apparently lost some of their power to assimilate nutrients from their ration.

The nitrogen and ash balances are shown in table XII.

TABLE XII. TEN-DAY NITROGEN AND ASH BALANCES

Lot	Nitrogen		Ash	
	Consumed, Gms.	Balance, Gms.	Consumed, Gms.	Balance, Gms.
I	153.49	50.30	523.26	79.40
	74.43	12.20	367.23	151.75
	79.01	3.30	235.03	—120.73
Total	306.93	65.80	1125.52	110.42
Average	102.31	21.93	375.17	36.807
II	64.72	—2.08	231.24	—47.73
	75.54	7.87	180.35	—47.02
	69.36	21.03	279.48	64.95
Total	209.62	26.82	691.07	—29.80
Average	69.87	8.94	230.36	—9.93
III	129.34	16.91	462.48	—242.70
	153.41	33.14	367.20	—78.36
	125.12	24.67	501.68	94.46
Total	407.87	74.72	1331.36	—226.60
Average	135.96	24.97	443.79	—75.53
IV	64.67	14.25	231.24	—44.80
	76.70	21.33	183.60	—52.59
	69.36	13.54	279.48	1.68
Total	210.73	49.12	694.32	—95.71
Average	70.24	16.37	231.44	—31.903

The nitrogen balance figures indicate that the lot IV ewes stored a greater percentage of their nitrogen than did the ewes in any of the other lots. Whether or not this indicates a more economical use of protein is not known, yet the lot IV ewes seem to make a much more economical use of their nitrogen than do the ewes in lot III.

The lot I ewes were the only ones which showed a positive ash balance. All the other ewes were losing mineral matter from their bodies.

LITERATURE CITED

1. Anonymous. 1922.
   What to use to make mutton and wool.
   Livestock Journal 96:441.
2. Anonymous. 1924.
   Wool facts.
   Mimeographed sheets from the Dubois Sheep Experiment Station.
   June, 1924.

3. Burns, Robert H., and Koehler, W. B. 1925.
The micrometer caliper as an instrument for measuring the diameter of wool fibers.
Wyoming Agr. Exp. Sta. Bul. 141.

4. Burns, Robert H. 1935.
The micrometer caliper for measuring the thickness of wool fibers.
Wyoming Agr. Exp. Sta. Bul. 204.

5. Cook, W. W., and Jones, L. R. 1891.
Wool and wool measurements.
Vt. Agr. Exp. Sta. Rept. 1890. 4:55:64.

6. Craig, John A. 1896.
Grain feeding lambs for market.
Wis. Agr. Exp. Sta. 15th Ann. Rpt. p. 59.

7. Curtiss, C. F. 1922.
Iowa Agr. Exp. Sta. Rpt. 1922. p. 20.

8. Darlow, A. E.; Heller, V. G., and Felton, W. R. 1934.
The effect of the ration on wool growth and on certain wool characteristics.
Okla. Agr. Exp. Sta. Bul. 220.

9. Davenport, C. B., and Ritzman, E. G. 1926.
Some wool characters and their inheritance.
N. H. Agr. Exp. Sta. Tech. Bul. 31.

10. Evvard, John M., and Culbertson, C. C. 1924.
Salting the ewes.
Iowa Agr. Exp. Sta. Leaflet 98.

11. Hammond, J. W. 1916.
Wool studies.
Ohio Agr. Exp. Sta. Bul. 294.

12. Hammond, J. W. 1922.
Wintering rations for breeding ewes.
Ohio Agr. Exp. Sta. Bul. 358.

13. Hardy, J. I. 1918.
Influence of humidity upon the strength and elasticity of wool fiber.
Jour. Agr. Res. 14:285-296.

14. Hardy, J. I. 1920.
Further studies on the influence of humidity upon the strength and elasticity of wool fiber.
Jour. Agr. Res. 19:55-62.

15. Hardy, J. I., and Tennyson, J. B. 1930.
Wool fineness as influenced by rate of growth.
Jour. Agr. Res. 40:457-467.

16. Henry, W. A., and Morrison, F. B. 1902.
Feeds and feeding.
Henry Morrison Company, Ithaca, N. Y. 18th edition, p. 584.

17. Hill, J. A. 1912.
The value of fiber testing machines for measuring the strength and elasticity of wool.
Wyoming Agr. Exp. Sta. Bul. 92.

18. Hill, J. A. 1921.
Studies in the variation and correlation of fleeces from range sheep.
Wyoming Agr. Exp. Sta. Bul. 127.

19. Joseph, W. E.
Effect of feeding and management on the tensile strength and elasticity of wool.
Jour. Agr. Res. 33:1073-1089.

20. Lush, J. L., and Jones, J. M. 1923.
The influence of individuality, age, and season upon the weights of fleeces produced by range sheep.
Texas Agr. Exp. Sta. Bul. 311.

21. Masterdon, William Perry (Penrose). 1926.
Wool growing in New Zealand.
New Zealand Jour. Agr. 32:6.

22. Marston, Hedley R. 1928.
The chemical composition of wool.
Commonwealth of Australia Bul. No. 38.

23. Marston, Hedley R. 1932.
The production of wool fleece by Merino sheep.
Australian Jour. Exp. Biol. and Med. Sci. 9:235-246.

24. Marston, Hedley R., and Robertson, T. Bradsford. 1928.
The utilization of sulphur by animals with especial reference to wool production.
Commonwealth of Australia Bul. No. 39.

25. Roux, L. L. 1926.
Factors affecting wool production.
Amer. Sheep Breeder and Wool Grower 46:7.

26. Russell, H. L. 1913.
Influence of sulphur in feeds upon wool production.
Wis. Agr. Exp. Sta. Bul. 228, pp. 37, 38.

27. Russell, H. L., and Morrison, F. B. 1923.
Science serves the farm.
Wis. Agr. Exp. Sta. Bul. 353.

28. Snedecor, George W. 1934.
Calculation and interpretation of analysis of variance.
Collegiate Press, Ames, Iowa.

29. Spencer, D. A.; Hardy, J. I., and Brandon, Mary J. 1928.
Factors that influence wool production with range Rambouillet sheep.
U. S. D. A. Tech. Bul. 85.

30. Weber, A. D. 1931.
The effect of the plane of nutrition on wool growth.
Proc. Amer. Soc. An. Prod., pp. 228-230.

31. Wilson, J. F. 1931.
The influence of the plane of nutrition upon various factors related to wool production.
The National Wool Grower, 31:23-28.

32. Wilson, J. F. 1934.
Relation of the sheep's health to the growth rate of wool.
Textile Research, Vol. 4, No. 9, pp. 436-439.

33. Wilson, J. F. 1935.
The effect of sickness on the growth rate of wool.
The National Wool Grower, Vol. 25, No. 5, p. 20.

34. Youatt, William. 1848.
Youatt on sheep.
Orange, Judd & Co., New York, pp. 14, 15.

35. Zuntz, N. 1920.
Zur Hebrung des Wallertrage Unserer Schafe.
Biedermann's Zentralblatt Fur Agrikaltur Chemie, 49:189.